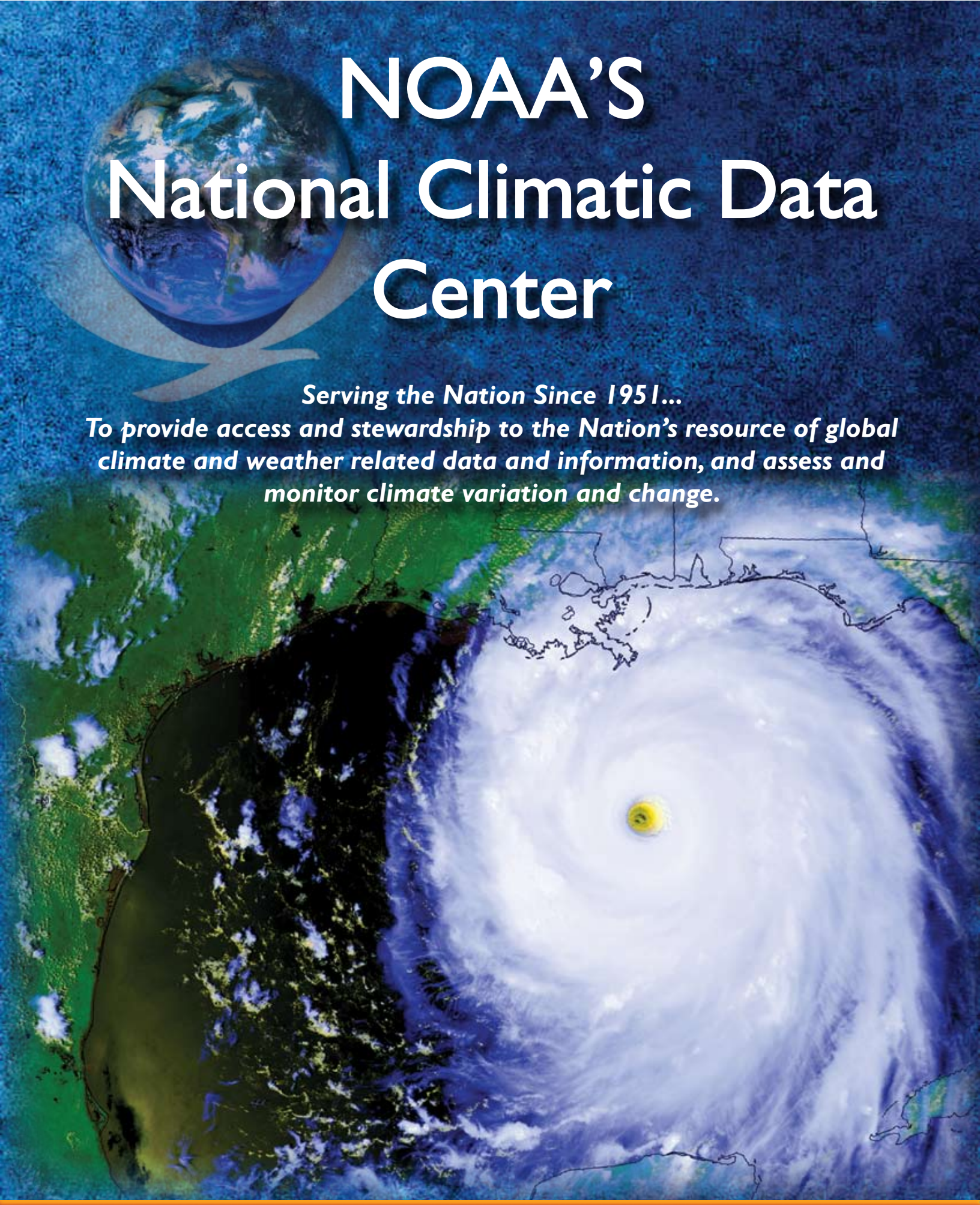
NOAA'S National Climatic Data Center

Serving the Nation Since 1951...
To provide access and stewardship to the Nation's resource of global climate and weather related data and information, and assess and monitor climate variation and change.

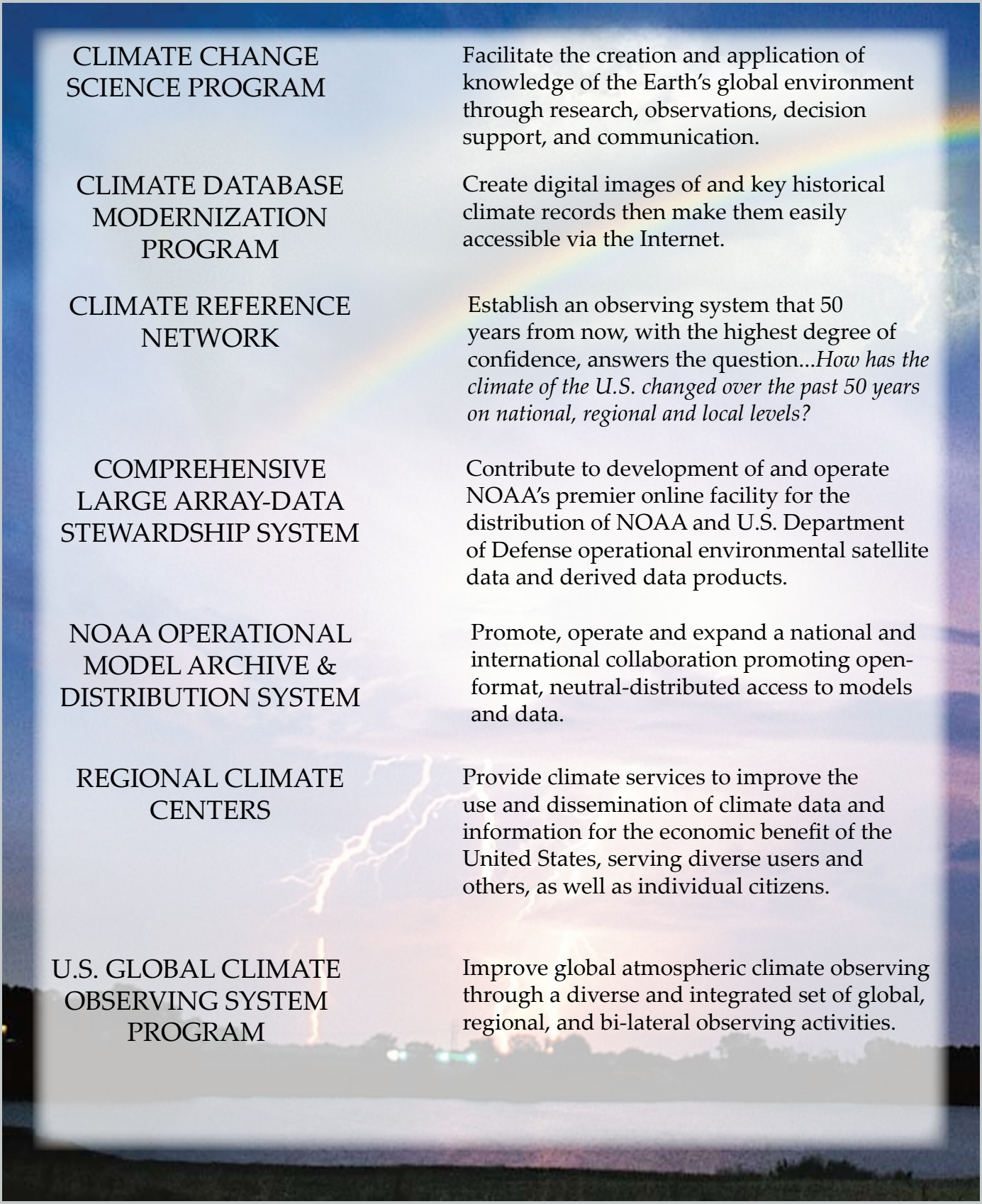


ANNUAL REPORT 2005

N C D C A T

DATA OPERATIONS	Ingest, process, and archive NOAA's environmental data ensuring data quality, integrity, and accessibility.
SCIENTIFIC SERVICES	Use the instrumental and paleoclimatic record to monitor and provide high quality information on current and past climate variability and change.
CLIMATE SERVICES	Provide customer service for climate products and information, manage online access systems utilizing e-Government concepts.
SUPPORT SERVICES	Provide quality Information Technology, financial, logistical and contractual support to NCDC programs and activities which contribute toward meeting our Nation's economic, social and environmental needs.
REMOTE SENSING and APPLICATIONS	Develop, distribute, and assist in the production, update and stewardship of climate data records from NOAA's satellite and radar data.

A GLANCE



CLIMATE CHANGE SCIENCE PROGRAM	Facilitate the creation and application of knowledge of the Earth's global environment through research, observations, decision support, and communication.
CLIMATE DATABASE MODERNIZATION PROGRAM	Create digital images of and key historical climate records then make them easily accessible via the Internet.
CLIMATE REFERENCE NETWORK	Establish an observing system that 50 years from now, with the highest degree of confidence, answers the question...*How has the climate of the U.S. changed over the past 50 years on national, regional and local levels?*
COMPREHENSIVE LARGE ARRAY-DATA STEWARDSHIP SYSTEM	Contribute to development of and operate NOAA's premier online facility for the distribution of NOAA and U.S. Department of Defense operational environmental satellite data and derived data products.
NOAA OPERATIONAL MODEL ARCHIVE & DISTRIBUTION SYSTEM	Promote, operate and expand a national and international collaboration promoting open-format, neutral-distributed access to models and data.
REGIONAL CLIMATE CENTERS	Provide climate services to improve the use and dissemination of climate data and information for the economic benefit of the United States, serving diverse users and others, as well as individual citizens.
U.S. GLOBAL CLIMATE OBSERVING SYSTEM PROGRAM	Improve global atmospheric climate observing through a diverse and integrated set of global, regional, and bi-lateral observing activities.

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2005 Annual Report

NOAA's National Climatic Data Center (NCDC)
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Message from the Director

The National Oceanic and Atmospheric Administration's (NOAA's) National Climatic Data Center's (NCDC's) Annual Report focuses on the activities and accomplishments at NCDC during 2005. In collaboration with our partners, both internal and external to NOAA, I am pleased to report that NCDC met or exceeded all its performance measures, sometimes surpassing them by a considerable margin. Each year we embrace the challenge to provide our broad-base of users with climate data and information products of the highest-quality. *Our mission is to provide access and stewardship to the Nation's resource of global climate and weather related data and information, and assess and monitor climate variation and change.*

NCDC has a dedicated staff as demonstrated by a sample of our achievements this past year as listed below:

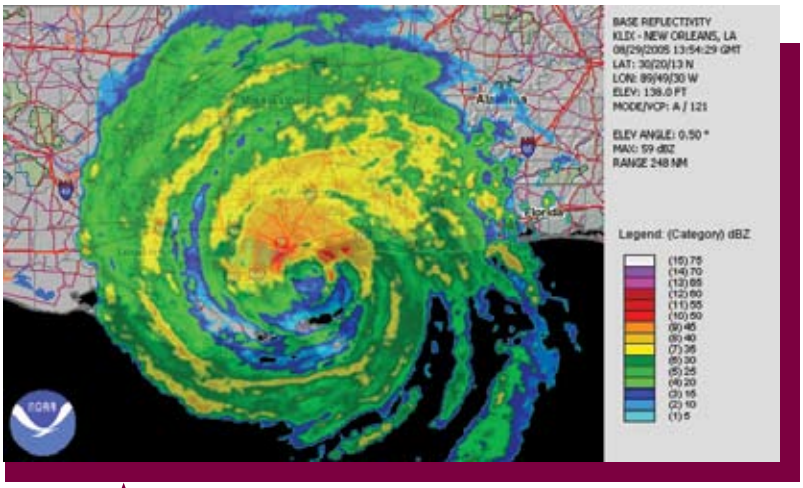
- Radar Data Interactive Viewer for custom data access (page 1)
- Climate Data Online interface provides improved access to global datasets (page 1)
- Hurricane Katrina report on meteorological conditions and climatological perspective (page 3)
- New global land and ocean surface data set (page 4)
- Aviation information for convective weather activity made available (page 5)
- Optimum interpolation for sea surface temperature analysis improved (page 5)
- Nation's first Climate Change Science Program 'Synthesis and Assessment' report released for public comment (page 6)
- Climate Reference Network implementation continued (page 7)
- Bi-lateral climate partnership activities around the world (page 10)
- Regional Climate Centers support NOAA Climate Program priorities (page 11)
- Summer Internship Program (page 12)

NCDC has an important responsibility in our Nation's ability to address public safety, protection of property, homeland security, sustainable development, and environmental awareness. Each year weather and climate, and especially weather and climate disasters, have a major impact on the lives of our Nation's citizens. We have also issued numerous public reports detailing the state of the climate and important developments such as the impact of Hurricane Katrina on the Gulf coast.

It is increasingly important that NCDC develops partnerships with the private sector, academia, and other government agencies to ensure we most effectively address these issues. NCDC plays a principal role in NOAA's Climate Services Program and will continue to expand its efforts, in collaboration with other organizations. The achievements identified in this report and many others not listed would not be possible without the superlative effort put forth by our gifted and dedicated personnel working with our partners throughout government, the private sector and academia. I offer my gratitude and praise to our personnel and our partners for such fine work. The NCDC looks forward to an even better performance next year in providing the best climate information service possible to the citizens of our Nation.

Thomas R. Karl,
Director

Data Operations



The last Hurricane Katrina image from the New Orleans radar before it lost power.

Radar Data Visualization

The NOAA generates, on average, 80 terabytes of NEXt generation RADar (NEXRAD) data and products annually. These data are in high demand globally by both the public and private sectors. As much as one terabyte of data is accessed monthly through NOAA's NCDC web site. To provide better support to end users, NCDC developed visualization tools for browsing and displaying these data. The NCDC NEXRAD Interactive Viewer and Data Exporter load NEXRAD volume scan data, known as Level-II and derived products, known as Level-III, into an OPEN Geographic Information System (GIS) compliant environment. The applications are launched via Java Web Start and run on the client machine while accessing the data remotely from the archive at the NCDC. The NEXRAD Interactive Viewer provides tools for custom data overlays, animations and basic queries. The export of images and movies is provided in multiple formats. The NEXRAD Data Exporter allows for data export in both vector polygon (Shapefile, GML, Well-Known Text) and raster formats. These tools are now part of university course curriculums, have assisted in Space Shuttle upper atmospheric electron distribution studies, are used by the National Transportation Safety Board (NTSB) aircraft accident investigations, are routinely used by government and university researchers, and are being used by other countries. "Obtaining NEXRAD data in a GIS format has been a major obstacle in furthering our research, and this tool is a substantial step forward" states the Director, Center for Research in Water Resources at the University of Texas at Austin. The NTSB states "this visualization tool is a great resource. It is now part of our standard operating procedures." A hydrometeorologist at the National Weather Service Radar Operations Center further noted that easy access to radar data is instrumental in climate research and severe weather analysis, and it is also used in many other disciplines including hydrology, geography, biology and engineering.

Climate Services

Global Data Access

NOAA's NCDC Climate Data Online (CDO) system now provides easy access to global datasets of surface and marine weather/climate data, described below, in addition to U.S.-based networks. This includes the full period of digital record available for surface data, along with daily updates to the system for the most recent data. CDO is also integrated with our GIS interface, so that users can utilize either the menu-driven CDO interface or the map-based GIS interface. The URL is: http://cdo.ncdc.noaa.gov/CDO/cdo.

NCDC, in conjunction with Federal Climate Complex partners (U.S. Air Force and U.S. Navy), developed the global Integrated Surface Data (ISD, formerly Integrated Surface Hourly) database to address a pressing need for an integrated global database of surface climatological data. ISD is gradually being expanded to incorporate additional sources of surface data. The period of record is 1901 to present, and over 100 original sources are already incorporated into this dataset. The CDO system allows users to select data by region, country, state, and station, and for any desired time period. Output formats include a simplified space-delimited format with the key climatic elements, and a more advanced format, which allows the user to select just the elements desired – e.g., temperature and dew point.

The International Comprehensive Ocean Atmosphere Data Set (ICOADS) comprises data from 1784 to the present, and includes data integrated from numerous sources. CDO allows users to select data by 1° latitude-longitude "square" for any desired time period. Output formats include the often-used "common marine" format (formerly DS1129), a space-delimited format, and the ICOADS archive format.

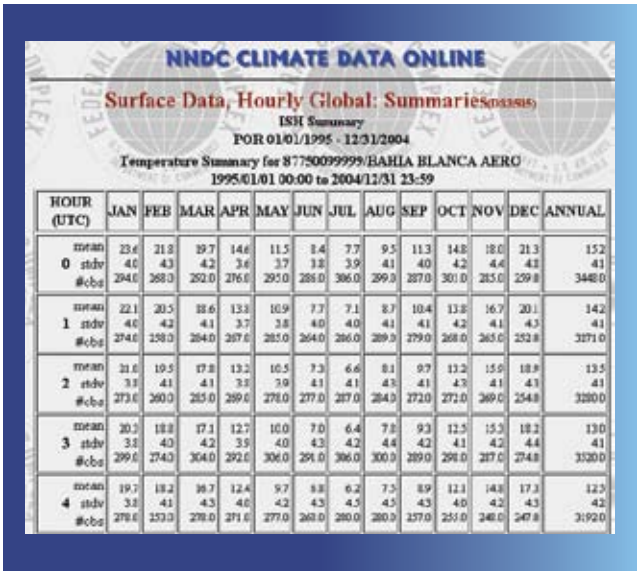
Geographic Information System Capabilities

A new and improved GIS map services interface is now online. It is more user-friendly with some additional features, and provides a direct interface to all major datasets. The datasets now included are:

- Global Climate Observing System (GCOS) global monthly data;
- Global monthly data from CLIMAT bulletins;
- Global hourly and synoptic data from the ISD;
- U.S. daily data from National Weather Service cooperative and first-order stations;
- U.S. monthly data from National Weather Service cooperative and first-order stations;
- U.S. hourly precipitation data from National Weather Service cooperative and first-order stations; and
- U.S. 15-minute precipitation data from National Weather Service cooperative and first-order stations.

Collectively, this includes data from over 50,000 observing stations worldwide. Monthly, daily, and hourly refer to the time resolution of the data – e.g., "monthly" includes data such as mean temperature and total precipitation for each month of available data. A variety of climatic elements are available for each dataset, with temperature and precipitation data being the most common; but many other parameters such as visibility, wind speed and direction, dew point, pressure, snowfall, snow depth, cloud data, etc., are available for some of the stations.

The interface provides basic and advanced options, with additional features available in the "advanced" menu. Once a station is selected, the user is then directed into the data access system to select the desired time period and retrieve the data. Additional features, layers, datasets, and options will continue to be added to the system. This is part of a NOAA National Virtual Data System coordinated effort to provide user-friendly access to NOAA data and products.


NNDC CLIMATE DATA ONLINE

Surface Data, Hourly Global: Summaries

ISH Summary

POR 01/01/1995 - 12/31/2004

Temperature Summary for 87750099999/BAHIA BLANCA AERO

1995/01/01 00:00 to 2004/12/31 23:59

HOUR (UTC)	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
0 mean	23.6	21.8	19.7	14.6	11.5	8.4	7.7	9.5	11.3	14.8	18.0	21.3	15.2
0 stdv	4.0	4.3	4.2	3.6	3.7	3.8	3.9	4.1	4.0	4.2	4.4	4.3	4.1
0 #obs	294.0	268.0	292.0	276.0	295.0	286.0	306.0	299.0	287.0	301.0	285.0	299.0	3448.0
1 mean	22.1	20.5	18.6	13.8	10.9	7.7	7.1	8.7	10.4	13.8	16.7	20.1	14.2
1 stdv	4.0	4.2	4.1	3.7	3.8	4.0	4.0	4.1	4.1	4.2	4.1	4.3	4.1
1 #obs	274.0	258.0	284.0	267.0	285.0	264.0	286.0	289.0	279.0	268.0	265.0	252.0	3271.0
2 mean	21.6	19.5	17.8	13.2	10.5	7.3	6.6	8.1	9.7	13.2	15.9	18.9	13.5
2 stdv	3.8	4.1	4.1	3.8	3.9	4.1	4.1	4.3	4.1	4.3	4.1	4.3	4.1
2 #obs	273.0	260.0	285.0	269.0	278.0	277.0	287.0	284.0	272.0	272.0	269.0	254.0	3280.0
3 mean	20.3	18.8	17.1	12.7	10.0	7.0	6.4	7.8	9.3	12.5	15.3	18.2	13.0
3 stdv	3.8	4.0	4.2	3.9	4.0	4.3	4.2	4.4	4.2	4.1	4.2	4.4	4.1
3 #obs	299.0	274.0	304.0	292.0	306.0	291.0	306.0	300.0	289.0	298.0	287.0	274.0	3520.0
4 mean	19.7	18.2	16.7	12.4	9.7	6.8	6.2	7.5	8.9	12.1	14.8	17.3	12.5
4 stdv	3.8	4.1	4.3	4.0	4.2	4.5	4.5	4.5	4.5	4.0	4.2	4.3	4.2
4 #obs	278.0	253.0	278.0	271.0	277.0	263.0	280.0	280.0	257.0	253.0	248.0	247.0	3192.0

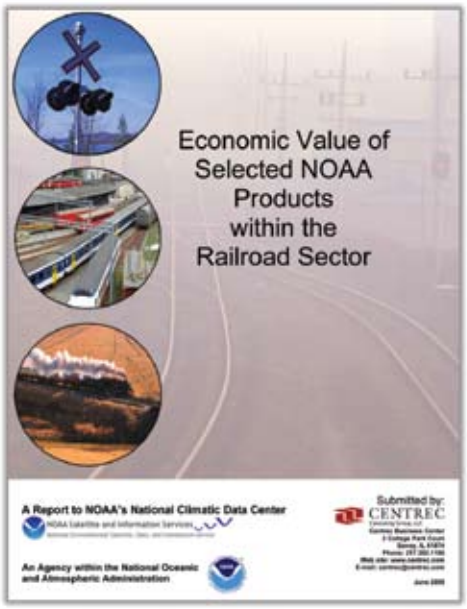
Global Integrated Surface Data (ISD) Summaries

After a successful joint effort with the U.S. Navy (collocated with NCDC), the ISD summary system is now online within the CDO system, and through a GIS interface. Thirteen different summaries can be generated, such as ceiling-visibility, dew point statistics, temperature statistics, flying conditions (different categories), relative humidity, sky cover, sea level and station pressure, and wind speed/direction. The summaries are available as "pre-generated" 5 and 10-year summaries, or as "on-the-fly" summaries for user-selected periods. The global surface database used as input has over 10,000 active stations.

The URL is: http://cdo.ncdc.noaa.gov/CDO/cdo.

Report on the Economic Value of NOAA Products

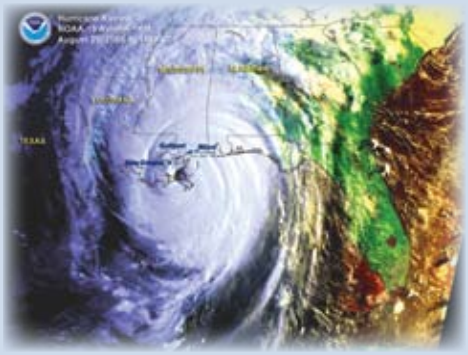
A report entitled *"The Economic Value of Selected NOAA Products within the Railway Sector"* was completed in June 2005 under contract to NOAA by Centrec Consulting Corporation. The report found that for every $1 that railway companies spend in acquiring NOAA climate data, they receive a potential benefit of saving almost $13,140 in infrastructure costs that would be required to maintain their own climate database storage, archiving, and reporting system. Extrapolating the savings to the entire U.S. railway market yields a potential benefit of $11.5 million. The report also found that railway companies use the NOAA's e-Government systems 91% of the time to order their climate data and only 9% of the orders are received by telephone.



This exemplifies NOAA's efforts in achieving the President's Management Agenda of expanding e-Government.

Scientific Services

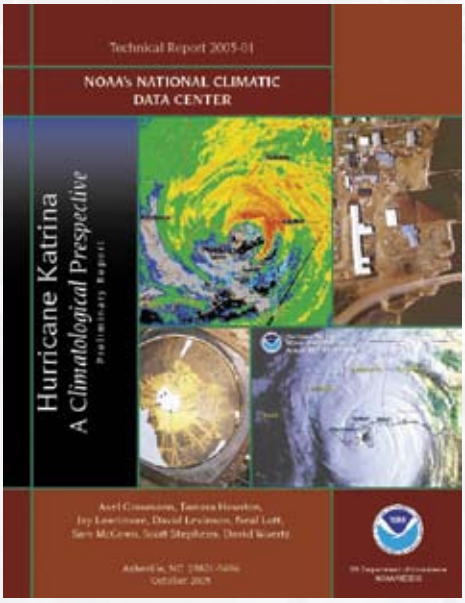
Katrina was one of the strongest storms to impact the coast of the United States during the past 100 years.



Hurricane Katrina

In the wake of Hurricane Katrina, NOAA's NCDC issued a special report that provided a summary of the meteorological conditions, impacts and climatological perspective from this historic storm. At its highest intensity, Katrinia was a category 5 storm (on the Saffir-Simpson scale) with wind speeds of 175 mph. Katrina weakened slightly as it approached the central Gulf Coast. Wind speeds were approximately 127 mph at landfall (a strong category 3 hurricane), minimum central pressure was the third lowest on record at landfall (920mb), and hurricane force winds stretched 120 miles from its center, causing widespread devastation along the central Gulf Coast states of the U.S.

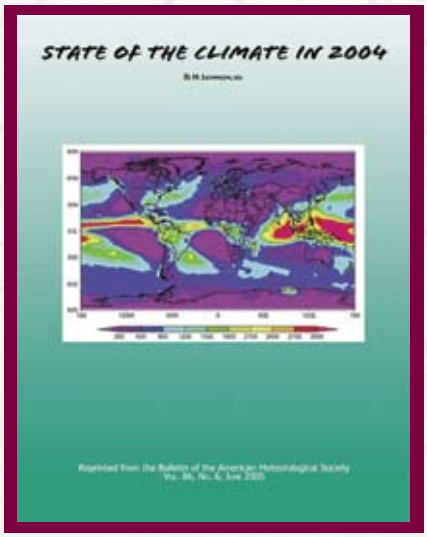
The storm made initial landfall at Plaquemines Parish in southeastern Louisiana on the morning of August 29, and the cities of New Orleans, Louisiana; Mobile, Alabama; and Gulfport, Mississippi, bore the brunt of Katrina's force as it moved inland. The associated storm surge, did not abate as the intensity of the storm slightly diminished before landfall and it reached as far east as Mobile, Alabama, leading to inundation of parts of the city. Large parts of Biloxi and Gulfport, Mississippi, were covered with water as a result of a 20 to 30+ foot storm surge that reached far inland. The combination of strong winds, heavy rainfall and storm surge led to breaks in the earthen levee system that separates New Orleans from surrounding lakes and canals. Widespread destruction along the Mississippi coastline, combined with the New Orleans levee breaks that left 80% of the city flooded, resulted in more than 1,000 deaths and economic losses that will far exceed the previous record losses from Hurricane Andrew ($38B in 2005 dollars).



The most deadly hurricane to strike the U.S. made landfall in Galveston, Texas, on September 8, 1900.

The Galveston hurricane was the greatest natural disaster to ever impact the U.S., claiming from 6,000 to 10,000 lives when the hurricane's storm surge caught the residents of this island city by surprise.

The 2005 Atlantic hurricane season set several records. There were 27 named storms (storms with sustained winds of at least 39 mph). In addition, there were an unprecedented 15 hurricanes, of which seven were major hurricanes (Category 3 or better on the Saffir-Simpson Scale). Three category 5 storms (sustained winds of 156 mph or more) formed in the Atlantic Basin for the first time in a single season (Katrina, Rita, and Wilma). Four major hurricanes and three tropical storms made landfall in the U.S., when an eighth storm (Ophelia) brushed the North Carolina coast. In contrast, tropical cyclone activity was near to below average in the Eastern Pacific and Western North Pacific basins.



At the end of 2005 NCDC issued the Web-based 2004 Annual State of the Climate report. The average global surface temperature for the year was very near the record set in 1998. While the 1998 record occurred under the influence of an extremely strong El Niño episode, there was no such strong influence in 2005, rather the average temperature was due to unusual warmth across large parts of the globe throughout the year.

The 2005 annual average temperature for the United States was the 8th warmest on record.

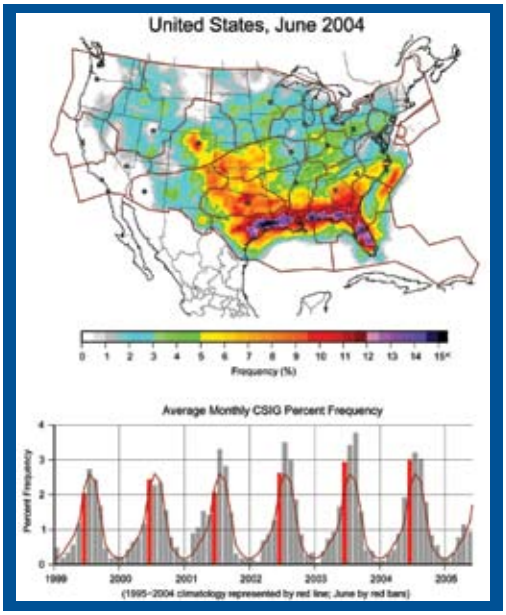
Temperature results were supported by a new global land and ocean surface dataset developed at NCDC in 2005. Among the improvements over existing global datasets, this temperature reconstruction, developed by NCDC's Tom Smith and Dick Reynolds, provides for the calculation of uncertainties in global temperature that are attributable to factors such as sampling errors and biases from changes in observational instruments and measurement techniques through time. The uncertainties associated with the various factors and methodologies used in dataset development made 2005 statistically indistinguishable from 1998.

Temperatures were warmer than average in 44 states and no state was cooler than average for the year. A July heat wave pushed temperatures soaring beyond 100 degrees, and broke more than 200 daily records established in six western states. A new record of seven consecutive days at or above 125^0 F was established at Death Valley, California.

Record and near-record winter precipitation in the Southwest eased drought in a region where drought had persisted for five years. Drought shifted to the Midwest and southern Plains in the spring and summer and drought disasters were declared in all or parts of Arkansas, Illinois, Iowa, Kansas, Missouri, Texas, and Wisconsin. The 'Blizzard of 2005' brought more than two feet of snow across much of southern New England in late January. This storm ranked as the seventh most extreme snow event in the Northeast as measured by a newly developed Northeast Snowfall Impact Scale index, which NCDC made operational in 2005. *The index was originally developed by NCEP's Louis Uccellini and The Weather Channel's Paul Kocin.*

Convective Significant Meteorological Information

At the request of the Federal Aviation Administration (FAA), NCDC, working with NOAA's Aviation Weather Center (AWC), developed a web site, which allows the FAA, airlines, pilots and the general public to view monthly distributions of frequency of aviation thunderstorm advisories, known as Convective SIGMETs (SIGnificant METeorological information, or CSIGs). CSIGs are issued by the AWC as a means of advising aircraft pilots of convective activity that is deemed hazardous to aviation. Each CSIG is a subjectively drawn polygon, line, or circle that depicts convection whenever a specified set of criteria are met. CSIG text bulletins are collected and archived on a daily basis at NCDC. At the end of each month, all CSIG reports are compiled and subjected to an analysis routine that identifies the location of all that were issued during the month. The location of each convective object (cell, area, or line) is based on latitude/longitude coordinates, which are made to overlay an array of 8 km x 8 km grid boxes across the continental U.S. and its surrounding waters. As each CSIG is evaluated, the 8 km x 8 km grid boxes that are part of the CSIG object are identified and tallied throughout the month. The Monthly CSIG frequency is the total number of "hits" per grid box divided by the total number of hours during the month. Maps of total CSIG frequency, as well as CSIG departures from a 10-year average (January 1995 - December 2004) are provided each month. The hourly mean (00:00 - 23:00 UTC) for each month (January - December) is also calculated for the 10-year period. Currently available are maps for the contiguous U.S., four regions of the U.S. (Northeast, South, Central, and Southwest), the 20 Air Route Traffic Control Centers and 20 of the Nation's major airports. These maps are available on NCDC's web site at: http://www.ncdc.noaa.gov/oa/climate/research/sigmet.

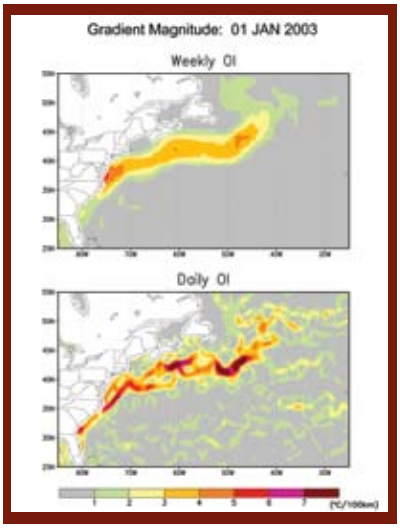


Remote Sensing and Applications

A Daily Blended Analysis for Sea Surface Temperature

A weekly optimum interpolation (OI) sea surface temperature (SST) analysis has been produced at the NOAA since 1993. The analysis is produced on a 1° spatial grid from November 1981 to present and uses bias corrected Advanced Very High Resolution Radiometer (AVHRR) infrared satellite retrievals and in situ SST observations from ships and buoys. The analysis has been widely used for weather and climate monitoring and forecasting.

A higher resolution version of the OI analysis is being produced daily on a 0.25° spatial grid for 1985-2005 at NCDC. The analysis uses in situ and Pathfinder AVHRR satellite data. The results show that the gradient features in the daily OI (see figure) have been systematically improved over the weekly version. This occurs, as shown in the figure, even in the winter in the Gulf Stream region where AVHRR data are sparse due to cloud cover. The high resolution gradients in the daily OI have been independently verified using the near-all-weather measurement capability of Advanced Microwave Scanning Radiometer - Earth Observing System (AMSR-E) microwave satellite data. In the near future, daily OI analyses will be available on the NCDC web site in real-time from 1985 to present. The analyses will include both AVHRR and AMSR-E satellite data.



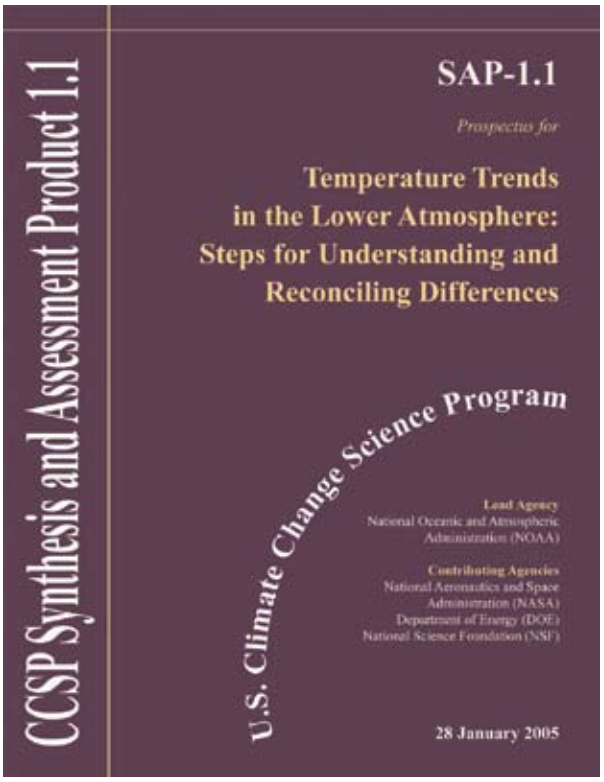
Monthly-averaged SST gradient magnitudes for January 2003 produced by two optimum interpolation (OI) analyses. Both analyses use in situ and AVHRR satellite data. The top panel shows the 1° weekly OI gradients; the bottom panel shows the 0.25° daily OI gradient.

Global High Resolution Sea Surface Winds from Multiple Satellites

The Earth's weather and climate system involves two major constantly changing components – the atmosphere and the ocean. These two components vigorously interact with each other over about 70% of the Earth's surface and these interactions directly regulate the Earth's water and energy cycles. Sea surface wind is one of the most dynamic parameters in the air-sea interaction. The World Meteorological Organization (WMO) World Climate Research Program Global Energy and Water Cycle Experiment requires global air-sea exchange rate (flux) products with resolutions as high as 3 to 6 hourly and 50 km. This is possible for sea surface wind speed since mid 2002 by utilizing presently available multiple satellites. High resolution and accurate winds are also needed to improve numerical weather and ocean forecasts including ocean waves and storm surges that cause costal erosions. Products on a global 0.25° grid are produced 4 times per day and are described at the NCDC website http://www.ncdc.noaa.gov/oa/rsad/blendedseawinds.html.

Climate Change Science Program

In 2001, President Bush established the U.S. Climate Change Research Initiative (CCRI) to investigate areas of uncertainty and future investment in global climate change science. The Climate Change Science Program (CCSP) incorporates the U.S. Global Change Research Program, established under the Global Change Research Act of 1990, and the CCRI, to improve the integration of scientific knowledge into effective policy-support decision making. A series of 21 individual CCSP Synthesis and Assessment (S&A) reports will examine seven primary scientific areas, including atmospheric composition, climate variability and change, the global water cycle, land use/land-cover change, global carbon cycle, ecosystems, and human contributions and responses.



NCDC Director Dr. Thomas R. Karl has served as Chair and editor for the first of these reports (CCSP S&A Product 1.1) entitled "*Temperature Trends in the Lower Atmosphere: Steps for Understanding and Reconciling Differences*." The primary focus of this report is to examine and update the conclusions of earlier reports from the U.S. National Research Council and the Intergovernmental Panel on Climate Change, in regard to observed surface and upper air global-mean temperature records and climate models. The second draft was released for 45 day public review November 17, 2005 - January 4, 2006.

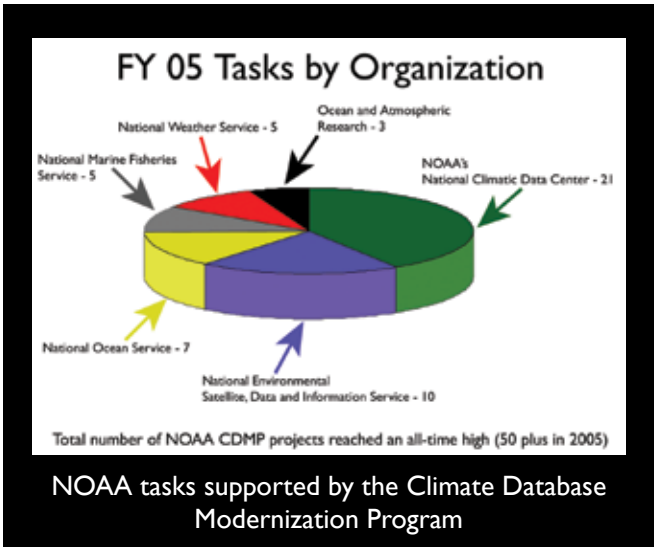
In mid-2006, Dr. Karl will begin leading a team of scientists to produce another report (CCSP S&A Product 3.3) entitled "*Climate Extremes including Documentation of Current Extremes*."

Climate Database Modernization Program

Data once restricted to file cabinets and basement storage are now becoming accessible via the World Wide Web for climate studies.

Access to Historical Data

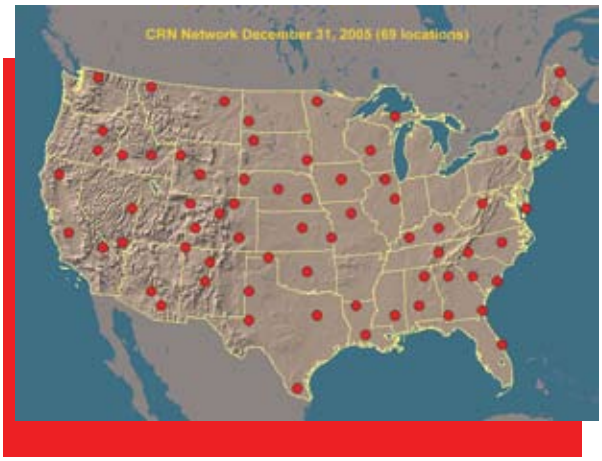
The sixth year of the Climate Database Modernization Program expanded in all NOAA operational line offices with services to make climate and environmental data and information more accessible and easier to use. Keying of surface and marine weather observations extended the historical period of record and the data are used in new reanalysis projects and climate studies. Historical data from Mexico and Africa were keyed and are available for global climate studies. Other historical data rescue activities in the National Marine Fisheries Service (lightship observations, fish egg and larvae, historical plankton, etc.), National Ocean Service (shoreline charts, nautical charts, water level gauges, etc.), and Office of Atmospheric Research (hurricane reconnaissance, European ship logbooks, etc.) all provide access to data that was previously only available to a few people. Projects are distributed across NOAA (see figure).



NOAA tasks supported by the Climate Database Modernization Program

Climate Reference Network

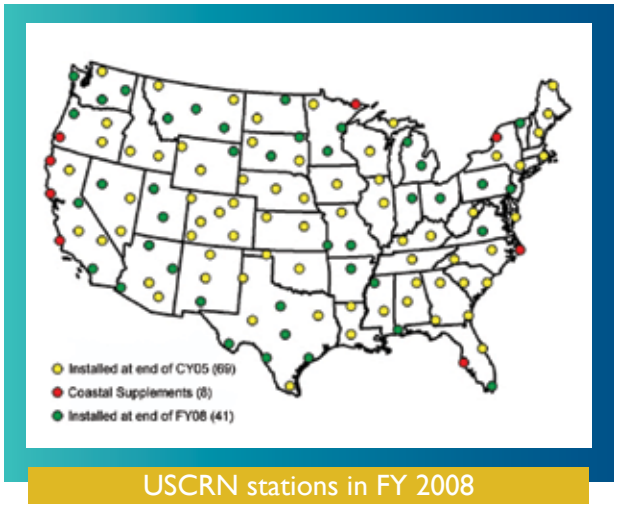
The Climate Reference Network (CRN) established seven CRN stations during Calendar Year 2005 in the contiguous 48 states. During the year, new CRN stations were installed in Alabama (2), Colorado, Florida, Kansas, Missouri, and North Carolina. The low number of stations deployed during the year is due to Fiscal Year 2005 funding limitations.



There were also new stations installed in Alaska and Hawaii that are part of the Global Climate Observing System. Finally there was also a Canadian version of a CRN station installed jointly with Canada at the Earth Resources Observation and Science Data Center of the United States Geological Survey at Sioux Falls, South Dakota, during the year.

During Hurricanes Katrina, Rita, and Wilma, only one of the CRN stations was impacted. The CRN site in Southern Mississippi lost public utility electricity for several days after Hurricane Katrina, but solar panels were installed before the station's internal batteries lost power so no data were lost. The amount of rainfall in the event was 12.7 inches. Although the primary purpose of CRN stations is to track climate change and variability at the annual, decadal, and national levels, the quality of the data and robustness of the CRN technology are valuable for assessing extreme events such as hurricane precipitation. Progress in reducing the climate uncertainty to the required national level comes in

small year-by-year annual increments and approaches the program's final goals asymptotically as the CRN nears completion in 2008. CRN will be complete when more than 40 additional CRN stations are deployed across the continental U.S. at specific geographic locations to meet the minimum acceptable program goals of national decision-maker needs for high-confidence science support (see figure).



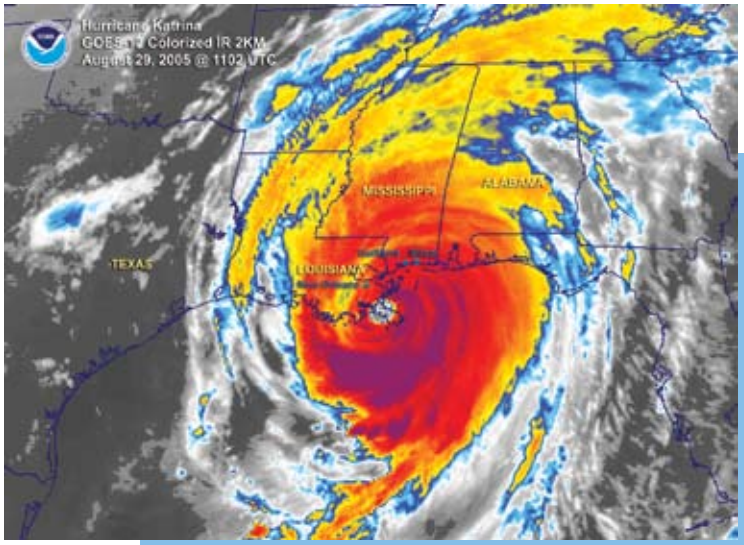
USCRN stations in FY 2008

Comprehensive Large Array-data Stewardship System

CLASS is NOAA's premier online facility for the distribution of NOAA and U.S. Department of Defense (DoD) operational environmental satellite data (Geostationary Operational Environmental Satellite, Polar-Orbiting Operational Environmental Satellite, Defense Meteorological Satellite Program) and derived data products.

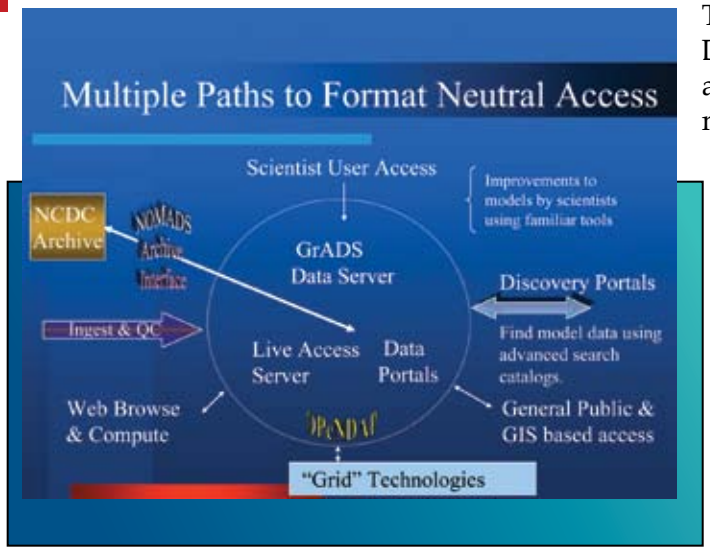
The Comprehensive Large Array-data Stewardship System (CLASS) is a web-based data archive and distribution system for NOAA's environmental data. The CLASS is a dual system with mirror sites at the NCDC and in Suitland, MD.

CLASS has made large amounts of historical geostationary satellite (GOES) data available free over the internet. In 2005, tens of terabytes of GOES data from the 1990s was loaded into CLASS and made available to the community. The response of the community was immediate and positive as dozens of users downloaded terabytes of these historical data for use in a variety of studies from climate to ecosystems. The ingest of historical GOES data will continue and, eventually, the entire historical series of GOES data from the late 1970s through the present will be available online.



To order data from or learn more about the CLASS, please visit http://www.class.noaa.gov.

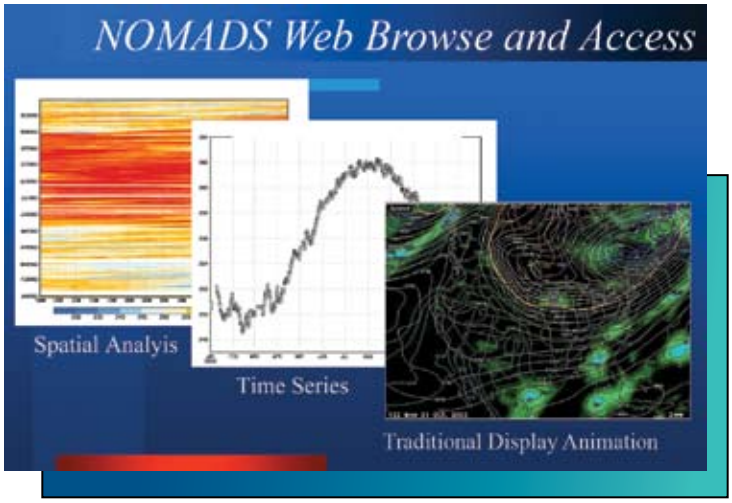
NOAA Operational Model Archive & Distribution System

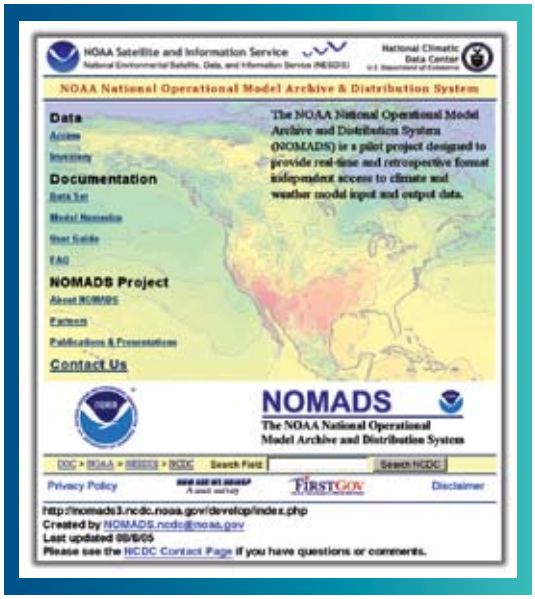


The NOAA National Operational Model Archive and Distribution System (NOMADS) project continues to advance easy access to highly complex, high volume, models and climate data sets during 2005.

In 2005 the NCDC NOMADS server provided 28 terabytes of model and observational data with accounting for approximately 11 million downloads. NOMADS now provides access to National Weather Service (NWS) official weather records and data as mandated by law; the NWS National Digital Forecast Database (NDFD); and limited satellite, radar, sea surface temperature; and other climate datasets. Finally, a new "mirror-server" was established at NCDC for backup services to the Real-Time (R/T) NOMADS server at the NWS National Centers for Environmental Prediction (NCEP).

The core technology for NOMADS is the Open-source Project for a Network Data Access Protocol (OPeNDAP) data transport protocol. NOMADS uses established and emerging technologies to provide access and integrate model and other data stored in geographically distributed repositories in heterogeneous formats. The data available under the NOMADS framework include model input and Numerical Weather Prediction (NWP) gridded output from NCEP; Global Climate Models (GCM); and reference quality in situ datasets. The goals of NOMADS are to improve access to NWP and GCM; improve the linkages between the research and operational modeling communities; provide the observational data and model analysis initialization products for Regional models, and for verification of forecast and climate models; and promote product development and collaborations within the geo-science communities (ocean, weather, and climate).





The NOMADS framework is actively partnering with existing and development activities including CLASS; the OPeNDAP community; and the Global Organization for Earth Systems Science Portals.

NOMADS has been cited as a potential pilot under both the United States Group on Earth Observations draft and NOAA's Global Earth Observing Integrated Data Environment documents. For additional information or data visit the following URL: http://nomads.ncdc.noaa.gov.

Note: *High resolution images can be provided upon request.*

The primary focus is to coordinate the development of a national GCOS program that involves all U.S. federal agencies with a role in climate observing and monitoring.

Bi-lateral Support Activities

In the past year the U.S. (via the State Department) has entered into a number of important bi-lateral climate agreements. Specifically, the U.S. GCOS Program Office is involved in funding projects with Australia, China, New Zealand, and South Africa. These bi-laterals cover a wide range of projects dealing with climate prediction, ocean observing, stratospheric detection, water vapor measurements, capacity building and training, and communication of information, and will focus the attention and resources of all these countries towards developing a more sustainable and robust GCOS program.

In conjunction with the National Institute of Water and Atmosphere (NIWA) in New Zealand, there are now two new projects which have been implemented on a long-term basis. The first one involves the implementation of a global stratospheric water vapor measurement station in Lauder, New Zealand. Water vapor is a key climate forcing agent and this new monitoring site will complement an existing site in Boulder, Colorado, which has been taking similar high-quality upper air water vapor measurements since 1980. A second significant project involves the implementation of a new ship track for trace gas measurements that has been implemented on a car carrier ship on a route between Nelson, New Zealand, and Nagoya, Japan. This is a brand new route and is unique in that it crosses both the Intertropical and South Pacific convergence zones; as such, the principal investigators from NOAA and NIWA believe the sampling of trace gases on this route will hold great promise for new and useful data. The ship shown has already made three tracks as of the end of Fiscal Year (FY) 2005 and there have been some interesting results, particularly in looking at the transport of methane (a key greenhouse gas) between the northern and southern hemispheres.

In conjunction with the South African Weather Service, the U.S. GCOS Program Office is also working to improve upper air observations in eastern and southern Africa via the establishment of an upper air maintenance and training facility. Joint work also continues on resurrecting the upper air station in Windhoek, Namibia, as well as upgrading ozone measurements at the Cape Lookout Global Atmosphere Watch (GAW) station in South Africa. A similar ozone measurement enhancement project at the GAW site at Mt. Waliguan in China is also underway via the U.S./China climate bi-lateral agreement. Finally, through work with the United Kingdom Met Office, a joint project has been implemented to refurbish the upper air observing site for climate in Yerevan, Armenia. Additionally, a new GCOS Technical Support Center has been spun up to serve southern and eastern Africa and is hosted by the Botswana Meteorological Service.

Enhanced Climate Data Management in the Pacific

NOAA, via the efforts of the U.S. GCOS Program Office, has recently taken a closer look at its data management activities in the Pacific region. The International Pacific Research Center (IPRC) located at the University of Hawaii is a bi-lateral U.S./Japan activity that is funded by Japan, NOAA, and the National Aeronautics and Space Administration. Specifically, NOAA funding is directed toward the operation of the IPRC's Asia Pacific Data Research Center (APDRC), and the U.S. GCOS Program Office also serves as the NOAA IPRC Program Manager. Links to the IPRC and APDRC can be found at: http://iprc.soest.hawaii.edu and http://apdrc.soest.hawaii.edu.

The vision of the APDRC is to link data management and preparation activities to research activities within a single center, and to provide one-stop shopping of climate data and products to local researchers and collaborators, the national climate research community, and the general public. ***The mission*** of the APDRC is to increase understanding of climate variability in the Asia-Pacific region: by developing the computational, data management, and networking infrastructure necessary to make data resources readily accessible and usable by researchers; and by undertaking data-intensive research activities that will both advance knowledge and lead to improvements in data preparation and data products.

In FY05, the first proposals process for the Pacific Region Integrated Data Enterprise was begun. A total of $1.2M was distributed to 14 Principal Investigators in the Pacific region to begin developing integrated environmental data products to benefit the region.

Regional Climate Centers

As part of the NOAA Climate Program under Regional Decision Support (RDS), the RCCs are the key player in partnerships between NOAA climate data organizations and regional, state, and local climate community partners.

For over twenty years, NOAA's Regional Climate Centers (RCC) Program has been recognized by Congress as vital to the efficient, coordinated delivery of NOAA climate services from national to local levels.

RCCs have an established and recognized infrastructure based on the Applied Climate Information System (ACIS; http://www.rcc-acis.org/), to nimbly support NOAA Climate Program priorities. In FY07, such priorities include supporting drought impact research for the National Integrated Drought Information System and continuing to invigorate RDS partnerships.

The RCC program fundamentally supports the NOAA Climate Program's "Engage, Advise, and Inform" strategy with the aim of supporting a climate-literate public, effectively incorporating NOAA's climate products into their lives, while also assuring that regional decision makers have access to climate information and products required to optimize societal performance.

- Sixty million web hits on Regional Climate Center sites
- Three dozen peer-reviewed climate research articles
- Climate query system deployed at 125 National Weather Service Offices
- Data discrepancy system deployed and maintained between NOAA and 150 data users
- Hundreds of climate maps produced in real-time

Information Delivery

After several years of sustained development, the ACIS has been fully integrated into the data dissemination activities of NOAA. Through internet portals, like NOWData, the public can now directly access consistent, quality-controlled, real-time climate information that is synchronized with NOAA data holdings.

ACIS is synchronized with NCDC climate databases to ensure an end-to-end delivery of climate information to users, from the 19th Century to yesterday. Building upon this seamless presentation of data, the RCCs have worked with Regional Decision Support Partners in NOAA to create ThreadEx—daily extremes for key U.S. weather stations.

The RCC program continues to work with NOAA and other partners to assure that ACIS continues to support vital data portals and bridge the gap between public requests and NOAA databases.

ThreadEx

Long-Term Station Extremes for America

Daily temperature and precipitation extremes in ThreadEx are based on combined regional station fragments.

American Association of State Climatologists

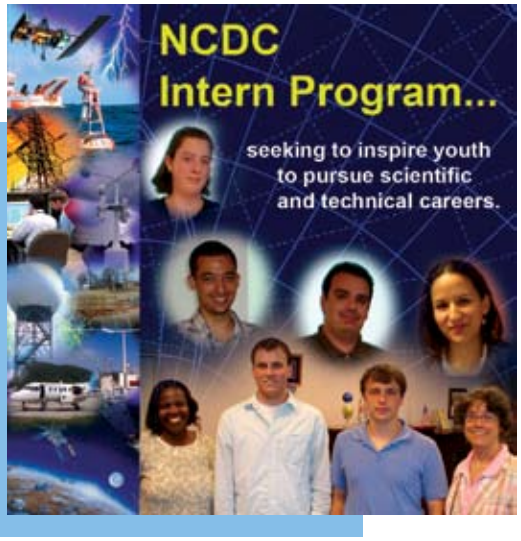
AASC

AMERICAN ASSOCIATION OF STATE CLIMATOLOGISTS

State Climatologists currently exist in over 40 states and territories. They are typically either employees of state agencies or are staff members of state-supported universities. Many State Climatologists are AASC-Recognized State Climate Offices in recognition of exceptional data service and outreach capabilities. For more info, see: http://www.ncdc.noaa.gov/oa/climate/aasc.html.

Outreach

NCDC hosted 18 students during its 2005 Summer Internship Program

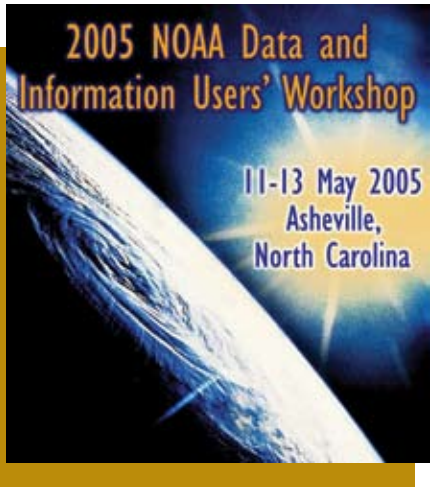


Two students were sponsored through the NOAA Graduate Science Program: one is attending the University of Hawaii and the other attends University of Alabama. The remaining students were from various programs including Entry Point sponsored by American Association for the Advancement of Science (AAAS), Oak Ridge Institute for Science and Education, Federal Career Intern Program, and the National Environmental Modeling and Analysis Center. The group also included several volunteers.

Several of the students represented area high schools and each intern was required to make a closing presentation. The student topics ranged from NOMADS' Live Access Server to Keywords. A site visit was conducted for Laureen Summers of the AAAS in Washington, DC. Several students are continuing work during

the school year. The NCDC Intern Program seeks to inspire youth to pursue scientific and technical careers. The interns were Anthony Arguez, Dustin Carter, Justin Crouch, Jessica Crowder, Corinne D'Ippolito, Alice DuViver, Andrea Fey, Richard Grube, Brandon Jarvis, Bryan Jones, Aaron Lindsay, Brian May, Deborah Moore, Nathaniel Rodgers, Ahira Sanchez, Kimberly Turley, and Bryan Zorn. *Sadly one of the interns, Jessica Crowder, was killed in an automobile accident two weeks after the program concluded.*

The 2005 NOAA Data and Information Users' Workshop was highly successful and presented a very positive image for NOAA.



Brigadier General (USAF retired) Jack Kelly with NOAA's Deputy Undersecretary Office provided the keynote address followed by Greg Withee. An action plan providing the status of recommendations received during the workshop will be posted in early 2006.

JOURNAL ARTICLES:

Aguilar, E., T.C. Peterson, P. Ramírez Obando, R. Frutos, J.A. Retana, M. Solera, I. González Santos, R.M. Araujo, A. Rosa Santos, V.E. Valle, M. Brunet India, L. Aguilar, L. Álvarez, M. Bautista, C. Castañón, L. Herrera, E. Ruano, J.J. Siani, F. Obed, G.I. Hernández Oviedo, J.E. Salgado, J.L. Vásquez, M. Baca, M. Gutiérrez, C. Centella, J. Espinosa, D. Martínez, B. Olmedo, C.E. Ojeda Espinoza, M. Haylock, R. Núnez, H. Benavides, and R. Mayorga, 2005: Changes in precipitation and temperature extremes in Central America and Northern South America, 1961-2003. *Journal of Geophysical Research - Atmospheres,* 110, D23107, doi:10.1029/2005JD006119 (December 2005).

Anderson, D.M., and C.A. Woodhouse, 2005: Climate change: let all the voices be heard (News and views). *Nature*, 433 (7026), 587-588 (10 February 2005).

Arguez, A., M.A. Bourassa, and J.J. O'Brien, 2005: Detection of the MJO signal from QuikSCAT. *Journal of Atmospheric and Oceanic Technology*, 22 (12), 1885-1894 (December 2005).

Durre, I., T. Reale, D. Carlson, J. Christy, M. Uddstrom, M. Gelman, P. Thorne, 2005: Improving the usefulness of operational radiosonde data. *Bulletin of the American Meteorological Society*, 86 (3), 411-416 (March 2005).

Easterling, D.R., G. Goodge, M.J. Menne, C.N. Williams, Jr., and D. Levinson, 2005: A comparison of local and regional trends in surface and lower tropospheric temperatures in western North Carolina. *Earth Interactions,* 9 (28), 1-9 (January 2005).

Free, M., D.J. Seidel, J.K. Angell, J. Lanzante, I. Durre, and T.C. Peterson, 2005: Radiosonde atmospheric temperature products for assessing climate (RATPAC): A new dataset of large-area anomaly time series. *Journal of Geophysical Research - Atmospheres,* 110, D22101, doi:10.1029/2005JD006169 (December 2005).

Gallo K., B. Reed, T. Owen, and J. Adegoke, 2005: Characteristics of seasonal vegetation cover in the conterminous USA. *Photogrammetric Engineering and Remote Sensing*, 71 (8), 959-966 (August 2005).

Groisman, P.Y., R.W. Knight, D.R. Easterling, T.R. Karl, G.C. Hegerl, V.N. Razuvaev, and N. Vyacheslav, 2005: Trends in intense precipitation in the climate record. *Journal of Climate,* 18 (9), 1343-1367 (1 May 2005).

Gupta, A.K., and D.M. Anderson, 2005: Mysteries of the Indian monsoon system. *Journal of the Geological Society of India*, 65 (1), 54-60 (January 2005).

Heim, R.R., Jr., 2005: Computing the monthly Palmer drought index on a weekly basis: A case study comparing data estimation techniques. *Geophysical Research Letters,* 32 (6), L06401, doi:10.1029/2004GL022118 2005 (18 March 2005).

Knapp, K.R., R. Frouin, S. Kondragunta, and A. Prados, 2005: Toward aerosol optical depth retrievals over land from GOES visible radiances: determining surface reflectance. *International Journal of Remote Sensing,* 26 (18), 4097-4116 (20 September 2005).

Levinson, D.H., ed., 2005: State of the Climate in 2004. *Bulletin of the American Meteorological Society*, 86 (6), S1-S86 (June 2005).

Meko, D.M., and C.A. Woodhouse, 2005: Tree-ring footprint of joint hydrologic drought in Sacramento and Upper Colorado river basins, western USA. *Journal of Hydrology* 308 (1-4), 196-213 (12 July 2005).

Menne, M.J., and C.N. Williams, Jr., 2005: Detection of undocumented change points using multiple test statistics and composite reference series. *Journal of Climate*, 18 (20), 4271-4286, doi:10.1175/JCL13524.1 (15 October 2005).

Peterson, T.C., 2005: Climate change indices. *WMO Bulletin,* 54 (2), 83-86 (April 2005).

Peterson, T.C., 2005: The workshop on enhancing South and Central Asian climate monitoring and indices, Pune, India, February 14-19, 2005. *CLIVAR Exchanges*, 10 (33), 6 (April 2005).

Peterson, T.C., and T.W. Owen, 2005: Urban heat island assessment: metadata are important. *Journal of Climate,* 18 (14), 2637-2646 (15 July 2005).

Peterson, T.C., Y. Boodhoo, V. Vent-Schmidt, P. Bessemoulin, and N. Plummer, 2005: WMO Commission for Climatology. *Bulletin of the American Meteorological Society*, 86 (1), 110-111 (January 2005).

Pielke, R.A., N. Doesken, O. Bliss, T. Green, C. Chaffin, J.D. Salas, C.A. Woodhouse, J.J. Lukas, and K. Wolter, 2005: Drought 2002 in Colorado, an unprecedented drought or a routine drought? *Pure and Applied Geophysics*, 162 (8-9), 1455-1479 doi:10.1007/s00024-005-2679-6 (August 2005).

Reynolds, R.W., H.-M. Zhang, T.M. Smith, C.L. Gentemann, and F. Wentz, 2005: Impacts of in situ and additional satellite data on the accuracy of a sea surface temperature analysis for climate. *International Journal of Climatology*, 25 (7), 857-864 (15 June 2005).

Shen, S.S.P., H. Yin, K. Cannon, A. Howard, S. Chetner, and T.R. Karl, 2005: Temporal and spatial changes of agroclimate in Alberta during 1901-2002. *Journal of Applied Meteorology*, 44, 1090-1105 (July 2005).

Smith, T.M., and R.W. Reynolds, 2005: A global merged land-air-sea surface temperature reconstruction based on historical observations (1880-1997). *Journal of Climate*, 18 (12), 2021-2036 (15 June 2005).

Smith, T.M., T.C. Peterson, J. Lawrimore, and R.W. Reynolds, 2005: New surface temperature analyses for climate monitoring. *Geophysical Research Letters*, 32 (14), L14712, doi:10.1029/2005GL02342 (4 pp.) (28 July 2005).

Sun, B., B. Baker, T.R. Karl, and M. Gifford, 2005: A comparative study of ASOS and USCRN temperature measurements. *Journal of Atmospheric and Oceanic Technology,* 22 (6), 679-686 (June 2005).

Sun, B., and T.C. Peterson, 2005: Estimating temperature normals for USCRN stations. *International Journal of Cimatology,* 25 (14), 1809-1817 (30 November 2005).

Vincent, L.A., T.C. Peterson, V.R. Barros, M.B. Marino, M. Rusticucci, G. Carrasco, E. Ramirez, L.M. Alves, T. Ambrizzi, M.A. Berlato, A.M. Grimm, J.A. Marengo, L. Molion, D.F. Moncunill, E. Rebello, Y.M.T. Anunciação, J. Quintana, J.L. Santos, J. Baez, G. Coronel, J. Garcia, I. Trebejo, M. Bidegain, M.R. Haylock, and D. Karoly, 2005: Observed trends in indices of daily temperature extremes in South America 1960-2000. *Journal of Climate,* 18 (23), 5011-5023, doi:10.1175/JCLI3589.1 (1 December 2005).

Vose, R.S., D. Wuertz, T.C. Peterson, and P.D. Jones, 2005: An intercomparison of trends in surface air temperature analyses at the global, hemispheric, and grid-box scale. *Geophysical Research Letters*, 32 (18), L18718 (4 pp.), doi:10.1029/2005GL023502, (28 September 2005).

Woodruff, S.H., F. Diaz, S.J. Worley, R.W. Reynolds, and S.J. Lubker, 2005: Early ship observational data and ICOADS. *Climatic Change*, 73 (1-2: CLIWOC, *Climatology of the World's Oceans* 1750-1850, special issues' name), 169-194 (November 2005).

Woodhouse, C.A., K.E. Kunkel, D.R. Easterling, and E.R. Cook, 2005: The twentieth-century pluvial in the western United States. *Geophysical Research Letters*, 32 (7), L07701 (4 pp.) (16 April 2005).

Worley, S.J., S.D. Woodruff, R.W. Reynolds, S.J. Lubker, and N. Lott, 2005: ICOADS release 2.1 data and products. *International Journal of Climatology*, 25 (7), 823-842 (15 June 2005).

Wylie, D., D.L. Jackson, W.P. Menzel, and J.J. Bates, 2005: Trends in global cloud cover in two decades of HIRS observations. *Journal of Cimate*, 18 (15), 3021-3031, doi:10.1175/JCL13461.1 (1 August 2005).

Zhang, X., E. Aguilar, S. Sensoy, H. Melkonyan, U. Tagiyeva, N. Ahmed, N. Kutaladze, F. Rahimzadeh, A. Taghipour, T.H. Hantosh, P. Albert, M. Semawi, M. Karam Ali, M.H.S. Al-Shabibi, Z. Al-Oulan, T. Zatari, I. Al Dean Khelet, S. Hamoud, R. Sagir, M. Demircan, M. Eken, M. Adiguzel, L. Alexander, T.C. Peterson, and T. Wallis, 2005: Trends in Middle East climate extreme indices from 1950 to 2003. *Journal of Geophysical Research - Atmospheres*, 110 (D22), D22104:10.1029/2005JD006181 (24 November 2005).

PROCEEDINGS:

Anderson, D.M., 2005: Monsoon dynamics observed over decades to millions of years. *AGU Chapman Conference on Tropical-Extratropical Climatic Teleconnections, a Long-term Perspective, February 8-11, 2005, University of Hawaii, Honolulu, Hawaii, USA*, S.I., Syracuse University-Geoff Seltzer, National Center for Atmospheric Research-Bette Otto-Bliesner, University of Massachusetts, NOAA/OAR Climate Diagnostics Center-Henry Diaz, University of Canterbury, and the University of Hawaii at Manoa, 33-34.

Ansari, S., and S. Del Greco, 2005: GIS tools for visualization and analysis of NEXRAD radar (WSR-88D) archived data at the NCDC. *85th AMS Annual Meeting, January 9-13, 2005, San Diego, CA*, American Meteorological Society, Boston, MA, J9.6 (9 p.).

Baldwin, R.T., and G. Reid, 2005: Symbology modification for climate studies, 2005. *2005 ESRI International User Conference Proceedings, July 25-29, 2005, San Diego, CA*.

Bates, J.J., R.G. Reynolds, C. Cremidis, and C. Martinez, 2005: CLASS capabilities overview. *85th AMS Annual Meeting, January 9-13, 2005, San Diego, CA*, American Meteorological Society, Boston, MA, JP1.9 (3 p.).

Bates, J.J., R.G. Reynolds, C. Cremidis, and C. Martinez, 2005: CLASS future plans. *85th AMS Annual Meeting, January 9-13, 2005, San Diego, CA*, American Meteorological Society, Boston, MA, P1.37 (5 p.).

Bates, J.J., R.G. Reynolds, C. Cremidis, and C. Martinez, 2005: GOES data in CLASS. *85th AMS Annual Meeting, January 9-13, 2005, San Diego, CA*, American Meteorological Society, Boston, MA, P1.36 (2 p.).

Bates, J.J., R.G. Reynolds, C. Cremidis, and C. Martinez, 2005: National Oceanic and Atmospheric Administration's scientific data stewardship program. *85th AMS Annual Meeting, January 9-13, 2005, San Diego, CA*, American Meteorological Society, Boston, MA, J2.3A (5 p.).

Diamond, H.J., 2005: Update on U.S. support for the Global Climate Observing System (GCOS) and associated support for international, regional, and bi-lateral GCOS activities. *21st International Conference on Interactive Information and Processing Systems for Meteorology, Oceanography, and Hydrology, January 2005, San Diego, CA*, American Meteorological Society, Boston, MA, J8.5 (5 p.).

Easterling, D.R., M. Menne, C.N. Williams, Jr., D. Levinson, and G. Goodge, 2005: Examining local and regional temperature changes for the 1977-2003 period using a truly homogeneous station record. *85th AMS Annual Meeting, January 9-13, 2005, San Diego, CA*, American Meteorological Society, Boston, MA, P1.24 (3 p.).

Gleason, K.L., J.H. Lawrimore, D.H. Levinson, and T.R. Karl, 2005: A revised U.S. climate extremes index. *85th AMS Annual Meeting, January 9-13, 2005, San Diego, CA*, American Meteorological Society, Boston, MA, P1.18 (6 p.).

Groisman, P.Y., B.G.Sherstyukov, V.N. Razuvaev, R.W. Knight, J.G. Enloe, N.S. Stroumentova, P.H. Whitfield, E. Forland, I. Hannsen-Bauer, H. Tuomenvirta, H. Aleksandersson, A.V. Mescherskaya, and T.R. Karl, 2005: Potential forest fire danger over northern Eurasia: changes during the 20th century. *Joint Sixth Symposium on Fire and Forest Meteorology/Interior West Fire Council Conference (19th), October 25-27, 2005, Canmore, Alberta, Canada*, American Meteorological Society, Boston, MA, 6.4 (13 p.).

Groisman, P.Y., R.W. Knight, P.H. Whitfield, G.C. Hegerl, V.N. Razuvaev, B.G. Sherstyukov, J.G. Enloe, and N.S. Stroumentova, 2005: Changes in precipitation distribution spectra and contemporary warming of the extratropics: implications for intense rainfall, droughts, and potential forest fire danger. *85th AMS Annual Meeting, January 9-13, 2005, San Diego, CA*, American Meteorological Society, Boston, MA, 12.5 (12 p.).

Guttman, N.B., 2005: Standardizing the quality assessment of data: partnership activities between NCDC and RCCs. *15th Conference on Applied Climatology/13th Symposium on Meteorological Observations and Instrumentation, June 19-23, 2005, Savannah, GA*, American Meteorological Society, Boston, MA, File J3.5 (2 p.).

Heim, Jr., R.R., 2005: An analysis of the impact of data inhomogeneities on the snow record. 1*5th Conference on Applied Climatology, June 19-23, 2005, Savannah, GA*, American Meteorological Society, Boston, MA, 1.8 (6 p.).

Heim, Jr., R.R., 2005: Overview and update of the North America drought monitor and North America climate extremes monitoring system. *15th Conference on Applied Climatology, June 19-23, 2005, Savannah, GA*, American Meteorological Society, Boston, MA, JP2.10 (2 p.).

Heim, Jr., R.R., and D.A. Robinson, 2005: Trends and variability of snowfall and snow cover across North America and Eurasia, part 1: data quality and homogeneity analysis [Online], *EOS Transactions, Fall Meeting, American Geophysical Union, December 5-9, 2005, San Francisco, CA*, 86 (52), C12a-05 (3 p.).

Levinson, D.H., R.R. Heim, Jr., S. Stephens, A.M. Waple, and C.Tankersley, 2005: The climate of 2004 in historical perspective. *85th AMS Annual Meeting, January 9-13, 2005, San Diego, CA*, American Meteorological Society, Boston, MA, 12.1 (8 p.).

Menne, M.J., H.V. Frederick, and S.A. Del Greco, 2005: Monitoring the health of weather and climate observing networks. *85th AMS Annual Meeting, January 9-13, 2005, San Diego, CA*, American Meteorological Society, Boston, MA, 18.14 (5 p.).

Morrill, C., B. Otto-Bliesner, E. Brady, and B. Briegleb, 2005: The effect of climate base state on the remote response to North Atlantic freshwater forcing: comparison of Heinrich and 8.2 ka events. *EOS Transactions*, *Fall Meeting supplement to AGU Fall Meeting, December 5-9, 2005, San Francisco, CA*, PP13B-1498.

Owen, T., 2005: Climate services partnerships: NOAA's National Climatic Data Center and regional climate centers. *2005 AAG Annual Meeting, April 6-12, 2005, Denver, CO*, Washington, DC, Association of American Geographers, 5535 (1 p.).

Owen, T., 2005: Cyberinfrastructure advances at NOAA's National Climatic Data Center and regional climate centers: quality feedback, assurance, and dissemination. *85th AMS Annual Meeting, January 9-13, 2005, San Diego, CA*, American Meteorological Society, Boston, MA, 17.4 (3 p.).

Owen, T., 2005: NOAA's National Climatic Data Center and regional climate centers: quality feedback, assurance, and dissemination. *Third Climate Prediction Applications Science Workshop, March 15, 2005, Palisades, NY*, International Research Institute for Climate Prediction, Columbia University, NY (17 p.).

Peterson, T.C., 2005: Climate extreme indices via regional climate change workshops. *85th AMS Annual Meeting, January 9-13, 2005, San Diego, CA*, American Meteorological Society, Boston, MA, P1.21 (5 p.).

Peterson, T.C., G.R. Hammer, and M.J. Menne, 2005: NCDC's GCOS lead center activities. *85th AMS Annual Meeting, January 9-13, 2005, San Diego, CA*, American Meteorological Society, Boston, MA, J8.11 (3 p.).

Robinson, D.A., and R.R. Heim, Jr., 2005: Trends and variability of snowfall and snow cover across North America and Eurasia, part 2: what the data say [Online], *EOS Transactions, Fall Meeting, American Geophysical Union, December 5-9, 2005, San Francisco, CA*, 86 (52), C12a-06 (5 p.).

Shi, L., and J.J. Bates, 2005: Distribution and variability of atmospheric temperature and water vapor derived from HIRS measurement. *85th AMS Annual Meeting, January 9-13, 2005, San Diego, CA*, American Meteorological Society, Boston, MA, J6.1 (6 p.).

Squires, M. F., 2005: The Northeast snowfall impact scale. *2005 ESRI International User Conference Proceedings, July 25-29, 2005, San Diego, CA*.

Sun, B., G.W. Goodge, and C.B. Baker, 2005: Preliminary analysis of the difference between temperature observations recorded by Coop and USCRN systems. *85th AMS Annual Meeting, January 9-13, 2005, San Diego, CA*, American Meteorological Society, Boston, MA, P4.6 (4 p.).

Sun, B., and T.C. Peterson, 2005: Estimating temperature normals for USCRN stations. *85th AMS Annual Meeting, January 9-13, 2005, San Diego, CA*, American Meteorological Society, Boston, MA, 8.4 (6 p.).

Urzen, M.L., and S.A. Del Greco, 2005: Automated validation for summary of the day precipitation data. *85th AMS Annual Meeting, January 9-13, 2005, San Diego, CA*, American Meteorological Society, Boston, MA, 18.13 (5 p.).

Zhang, H.-M., R.W. Reynolds, and T.M. Smith, 2005: Adequacy of in situ observing system in the satellite era for climate SST analysis. *85th AMS Annual Meeting, January 9-13, 2005, San Diego, CA*, American Meteorological Society, Boston, MA, J8.12 (5 p.).

OTHER:

Aguilar, E., R.G. Quayle, and J.M. Mitchell, Jr., 2005: Climatic variation, instrumental data. In: Oliver, J.E. (ed.), *Encyclopedia of World Climatology* (Encyclopedia of earth sciences series). Netherlands: Springer, 263-266 (August 2005).

Graumann, A., T. Houston, J. Lawrimore, D. Levinson, N. Lott, S. McCown, S. Stephens, and D. Wuertz, 2005: Hurricane Katrina, a Climatological Perspective, Preliminary Report. *NCDC technical report 2005-01. Asheville, NC*: NOAA's National Climatic Data Center, 2005. (October 2005).

Lott, N., T. Ross, A. Graumann, J. Kobar, and M. Lackey, 2005: Products and Services Guide [Online]. *National Climatic Data Center, Asheville, NC*: NOAA's National Climatic Data Center, 102 p. (ftp://ftp.ncdc.noaa.gov/pub/data/inventories/COMPLETE-GUIDE.PDF) (January 2005).

Lott, N., and T. Ross, 2005: Billion Dollar U.S. Weather Disasters 1980-2004 [Online]. *National Climatic Data Center, Asheville, NC*: NOAA's National Climatic Data Center, (1 html). (http://www.ncdc.noaa.gov/oa/reports/billionz.html) (January 2005).

Reynolds, R.W., and T.M. Smith, 2005: Hurricanes are getting more powerful ... and causing a lot more damage. *Time*, 166 (14), 45 (October 2005).

RCC ARTICLES:

Changnon, D., and S.A. Changnon, 2005: A very white Christmas. *Weatherwise*, 58, 36-40. [Mountain Regional Climate Center]

Changnon, S.A., and D. Changnon, 2005: Importance of sky conditions on the record 2004 Midwestern crop yields. *Physical Geography*, 26, 99-111. [Mountain Regional Climate Center]

Changnon, S.A., 2005: A bumper crop of scientific data: the Morrow Plots weather station. *Historic Illinois*, 28, 8-11. [Mountain Regional Climate Center]

Changnon, S.A., and D. Changnon, 2005: Lessons from the unusual impacts of an abnormal winter in the U.S.A., *Meteorological Applications*, 12, 187-191. [Mountain Regional Climate Center]

Faiers, G.E., B.D. Keim, K. Jammigumpula, and D. Sathiaraj, 2005: Analysis of 3-Hour and 24-Hour Extreme Rainfall in El Paso, Texas. *Pennsylvania Geographer*, 43 (1), Spring/Summer 2005. 21-31. [Southeast Regional Climate Center]

Hubbard, K.G., A.T. DeGaetano, K.E. Kunkel, and K.T. Redmond, 2005: Sources of uncertainty in the calculation of design weather conditions. *ASHRAE Transactions*, 111 (2), 317-326. [High Plains Regional Climate Center]

Hubbard, K.G., and H. Wu, 2005: Modification of a Crop-Specific Drought Index for Simulating Corn Yield in Wet Years. *Agron. J.*, 97, 1478-1484. (14674). [High Plains Regional Climate Center]

Hubbard, K.G., and J. You, 2005: Sensitivity analysis of quality assurance using spatial regression approach—a case study of maximum/minimum air temperature. *Journal of Atmospheric and Oceanic Technology*, 22 (10), 1520–1530, (14767). [High Plains Regional Climate Center]

Hubbard, K.G., X. Lin, and C.B. Baker, 2005: On the USCRN temperature system. *Journal of Atmospheric and Oceanic Technology*, 22 (7), 1092–1097. [High Plains Regional Climate Center]

Hubbard, K.G., S.Goddard, W.D. Sorensen, N. Wells, and T.T. Osugi, 2005: Performance of quality assurance procedures for an Applied Climate Information System. *Journal of Atmospheric and Oceanic Technology*, 22, 105-112, (14282). [High Plains Regional Climate Center]

Keim, B.D., L.D. Meeker, and J.F. Slater, 2005: Manual Synoptic Climate Classification for Coastal New England, USA with an Application to PM2.5 Concentration. *Climate Research*, 28, 143-153. [Southeast Regional Climate Center]

Keim, B.D., M.R. Fischer, and A. Wilson, 2005: Are there spurious precipitation trends in the United States climate division database? *Geophysical Research Letters*, 32, L04702, doi:10.1029/2004GL021985. [Southeast Regional Climate Center]

Kunkel, K.E., D.R. Easterling, K. Hubbard, K. Redmond, K. Andsager, M. Kruk, and M. Spinar, 2005: Quality control of pre-1948 cooperative observer network data. *Journal of Atmospheric and Oceanic Technology*, 22, 1691–1705. [Mountain Regional Climate Center]

Kunkel, K.E., R. Novak, R. Lampman, and W. Gu, 2006: Modeling the impact of variable climatic factors on the crossover of *Culex Restuans and Culex Pipiens (Diptera Culicidae)* vectors of West Nile Virus in Illinois. *American Journal of Tropical Medicine and Hygiene*, 74 (1), 168-173. [Mountain Regional Climate Center]

Kunkel, K.E. and X.-L. Liang, 2005: GCM Simulations of the climate in the central United States. *Journal of Climate*, 18 (7), 1016–1031. [Mountain Regional Climate Center]

Liang, X.-L., Xu, Min, W. Goa, K. Kunkel, J. Slusser, Y. Dai, Q. Min, P. Houser, M. Rodell, C. Schaaf, and F. Gao, 2005: Development of land surface albedo parameterization based on Moderate Resolution Imaging Spectroradiometer (MODIS) data. *Journal of Geophysical Research*, 110, D11107, doi:10.1029/2004JD005579. [Mountain Regional Climate Center]

Liang, X.-Z., H.I. Choi, K. E. Kunkel, Y. Dai, E. Joseph, J.X.L. Wang, and P. Kumar, 2005: Surface boundary conditions for mesoscale regional climate models. *Earth Interactions*, 9, 1–28. [Mountain Regional Climate Center]

Lin, X., K.G. Hubbard, and C.B. Baker, 2005: Surface air temperature records biased by snow-covered surface. *International Journal of Climatology*, 25**,** 1223-1250, doi:10.1002/joc.1184. [High Plains Regional Climate Center]

Mahmood, R. and K.G. Hubbard, 2005: Assessing bias in evapotranspiration and soil moisture estimates due to the use of modeled solar radiation and dew point temperature data. *Agricultural and Forest Meteorology*, 130, 71-84. [High Plains Regional Climate Center]

Pielke, R.A., Jr., S. Agrawala, L.M. Bouwer, I. Burton, S. Changnon, M.H. Glantz, W.H. Hooke, R.J.T. Klein, K. Kunkel, D. Mileti, D. Sarewitz, E.L. Thompkins, N. Stehr, and H. von Storch, 2005: Clarifying the Attribution of Recent Disaster Losses: A Response to Epstein and McCarthy. *Bulletin of the American Meteorological Society*, 86, 1481-1483. [Mountain Regional Climate Center]

Verma, S.B., A. Dobermann, K.G. Cassman, D.T. Walters, J.M. Knops, T.J. Arkebauer, A.E. Suyker, G.G. Burba, B. Amos, H. Yang, D. Ginting, K.G. Hubbard, A.A. Gitelson, and E.A. Walter-Shea, 2005: Annual carbon dioxide exchange in irrigated and rain-fed maize-based agroecosystems. *Agricultural and Forest Meteorology*, 131:77-96. [High Plains Regional Climate Center]

Westcott, N.E., S.E. Hollinger, and K.E. Kunkel, 2005: Relationship between normalized corn yield, monthly rainfall, and heat stress for the central United States. *Journal of Applied Meteorology*, 44, 1667–1676. [Mountain Regional Climate Center]

Wu, H., K.G. Hubbard, and J. You, 2005: Some concerns when using data from the Cooperative Weather Station Network: A Nebraska Case Study. *Journal of Atmospheric and Oceanic Technology*, 22 (5), 592-602, (14683). [High Plains Regional Climate Center]

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ACRONYMS

AAAS
American Association for the Advancement of Science

AASC
American Association of State Climatologists

ACIS
Applied Climate Information System

AMSR-E
Advanced Microwave Scanning Radiometer-Earth Observing System

APDRC
Asia Pacific Data Research Center

AVHRR
Advanced Very High Resolution Radiometer

AWC
Aviation Weather Center

CCSP
Climate Change Science Program

CCRI
Climate Change Research Initiative

CDO
Climate Data Online

CLASS
Comprehensive Large Array-data Stewardship System

CSIGs
Convective Significant Meteorological information

CRN
Climate Reference Network

FAA
Federal Aviation Administration

FY
Fiscal Year

GAW
Global Atmosphere Watch

GCM
Global Climate Models

GCOS
Global Climate Observing System

GIS
Geographic Information System

GOES
Geostationary Operational Environmental Satellite

ICOADS
International Comprehensive Ocean Atmosphere

IPRC
International Pacific Research Center

ISD
Global Integrated Surface Data

NCDC
National Climatic Data Center

NCEP
National Centers for Environmental Prediction

NEXRAD
Next Generation Radar

NIWA
National Institute of Water and Atmosphere

NOAA
National Oceanic and Atmospheric Administration

NOMADS
NOAA Operational Model Archive and Distribution System

NTSB
National Transportation Safety Board

NWP
Numerical Weather Prediction

OPeNDAP
Open-source Project for a Network Data Access Protocal

RCC
Regional Climate Centers

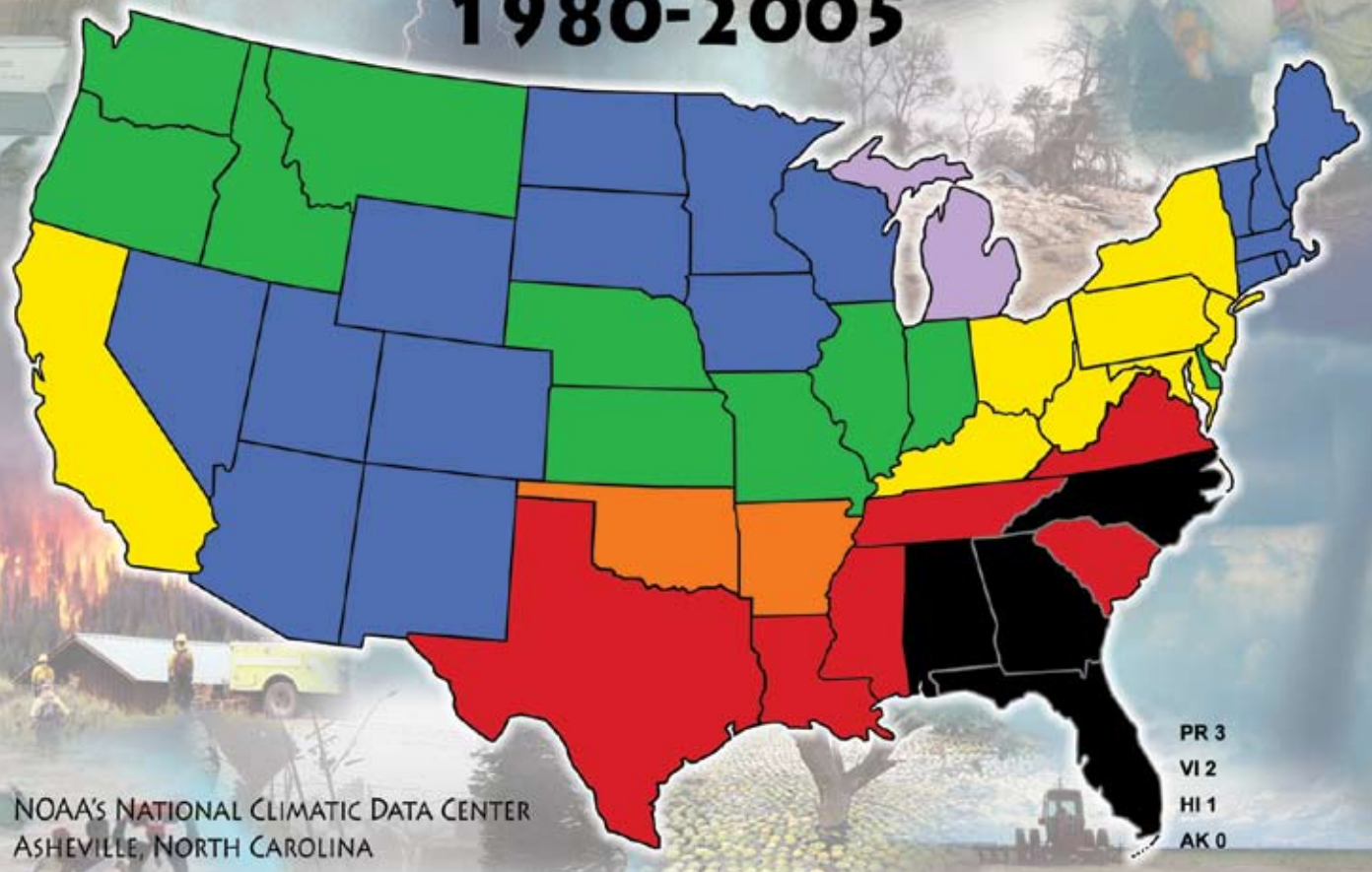
RDS
Regional Decision Support

S&A
Synthesis and Assessment

SST
Sea Surface Temperature

WMO
World Meteorological Organization

Billion Dollar Climate and Weather Disasters 1980-2005



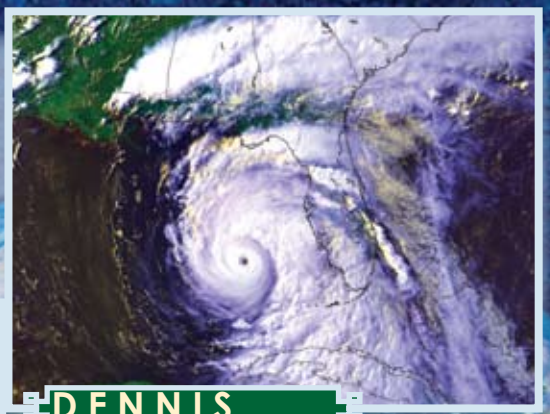
NOAA's National Climatic Data Center
Asheville, North Carolina

NUMBER OF EVENTS

	21 - 25
	16 - 20
	13 - 15
	10 - 12
	7 - 9
	4 - 6
	1 - 3

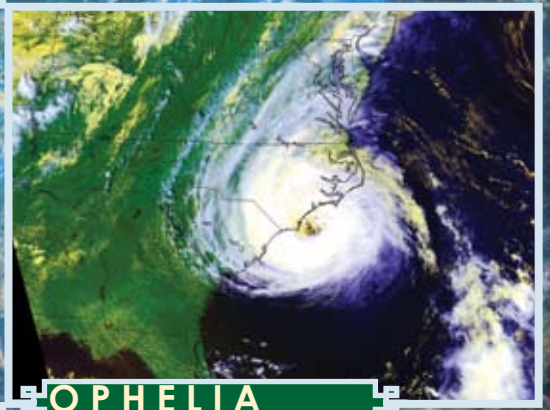
DISASTER TYPE	NUMBER OF EVENTS	PERCENT FREQUENCY	NORMALIZED DAMAGES (Billions of Dollars)	PERCENT DAMAGE
Tropical Storms/Hurricanes	24	35.8%	269	52.0%
Non-Tropical Floods	12	17.9%	55	10.6%
Heatwaves/Droughts	11	16.4%	145	28.1%
Severe Weather	7	10.4%	13	2.5%
Fires	6	9.0%	13	2.5%
Freezes	2	3.0%	6	1.2%
Blizzards	2	3.0%	9	1.7%
Ice Storms	2	3.0%	5	~1.0%
Noreaster	1	1.5%	2	~0.3%
	67		517	

Please note that the national map color-coded by state reflects a summation of billion dollar events, for each state affected--ie, it does not mean that each state shown suffered at least $1 billion in losses for each event.

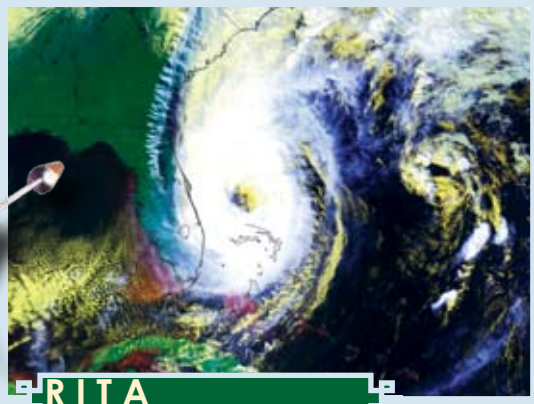


DENNIS

KATRINA



OPHELIA



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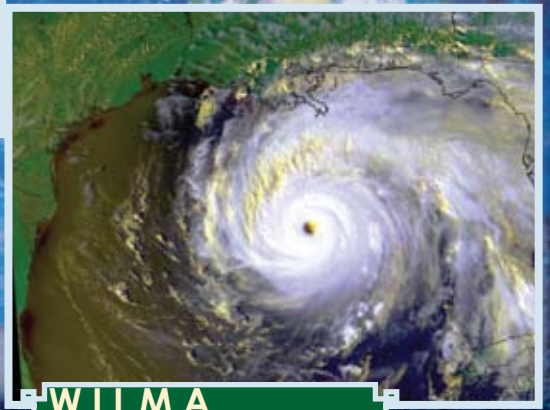

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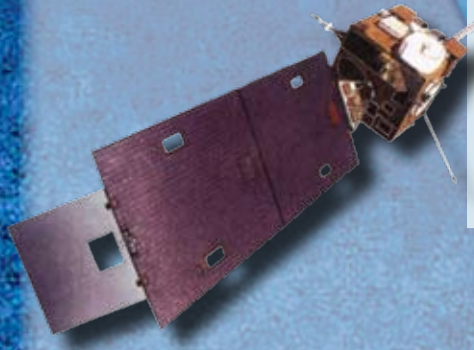

Protecting the past... Revealing the future